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AN *IN-SITU* AFM STUDY OF CANAVALIN PROTEIN CRYSTAL GROWTH

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In situ atomic force microscopy (AFM) has been used to investigate the growth of canavalin protein crystals as a function of supersaturation and pH. The results show that growth occurs on complex vicinal hillocks formed by screw dislocation sources. The activity of the various growth sources was monitored as a function of time and supersaturation ($0.6 \leq s \leq 3.1$). At very high supersaturation, 2D nucleation and island growth is observed to occur on the ~1 μm terraces generated by the dislocations. At lower supersaturations 2D nucleation is only observed to occur on large, artificially formed, ~15 μm terraces. No 2D island nucleation is observed on the terraces generated by the dislocations at these supersaturations, indicating that the terrace width is less than the diffusion length. Growth was monitored at a pH of 7.3, 7.7 and 8.0 and fundamental growth parameters were determined from the images. The dependence of terrace width on s and the size of the critical radius of capes and islands are used to estimate the free energy of the step edge. From the speed of the steps we calculate the kinetic coefficient for step motion. In this pH range, the kinetic coefficient has been found to vary from 3×10^{-4} cm/sec at pH 7.3 to 0.6×10^{-4} cm/sec at pH 8.0. The AFM images also reveal the mechanisms of defect incorporation during growth and provide insight into the processes that limit the growth rate and uniformity of these crystals. We find that at the typical conditions used to nucleate these crystals, the continual incorporation of micro-crystals that land on the surface results in extreme distortion of the lattice, the formation of "mosaic blocks" and planar defects, and ultimately leads to poor crystal homogeneity and diffraction quality. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48.